Systematic Hydrological Characterization of the Topopah Spring Lower Lithophysal Unit

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RESEARCH OBJECTIVES

Field experiments are being carried out in the lower lithophysal unit of the Topopah Springs welded tuff along the underground East-West Cross Drift at Yucca Mountain, Nevada, the potential site of a high level nuclear waste repository. These experiments are to investigate the hydrological properties that are important to repository performance. Parameters being measured are fracture permeability, effective porosity and characteristics of water seepage into the drift.

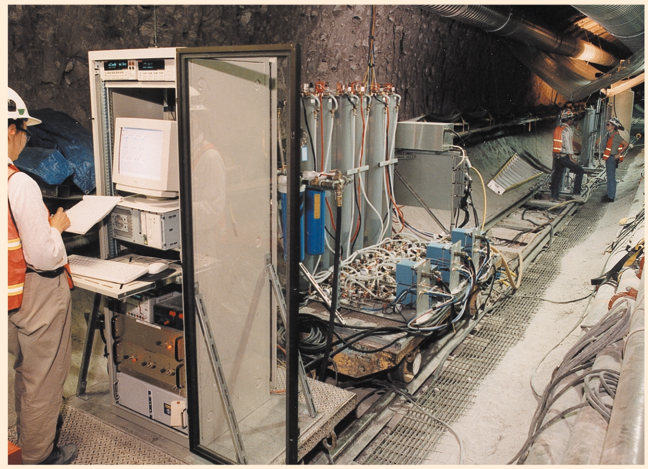

Figure 1. Equipment system for hydrological characterization in the Exploratory Studies Facility.

APPROACH

The lower lithophysal unit has many fractures that are less than 1 meter in length, and lithophysal cavities ranging in size from 15 to 100 cm abound. The cavity size and spacing vary significantly along the 5-meter drift walls within the same lower lithophysal unit, indicating that hydrological characteristics at one particular location are not likely representative of the entire lower lithophysal unit. Therefore, systematic testing at regular intervals along the drift is needed to gain an understanding not only of the hydrological characteristics but also the associated heterogeneities of this unit. Field tests are being carried out in 20-m-long boreholes that are drilled at 30-meter regular intervals from the crown of the East-West Cross Drift, parallel to and inclined at a low angle (~15°) from the drift axis. Each borehole is typically installed with a packer string consisting of three 3-m-long inflatable packers that isolate the borehole into three 2-m-long injection zones. Tests performed in each borehole interval involve air injection and liquid release. The fracture permeability is estimated by pressure responses to air injected into the borehole. Collection trays installed along the Cross Drift monitor the rate at which water seeps into the Cross Drift following liquid releases into the 2-m-long zone. Gas tracer tests to measure fracture porosity are carried out in pairs (separated by 3 meters) of parallel, horizontal boreholes drilled from the sidewall of the drift, systematically at 90-meter intervals.

The equipment system for all testing is assembled on two mobile flatbed rail cars as shown in Figure 1. In the foreground of photograph, on the first flatbed, the rack housing the computer, data acquisition system and power supplies is shown. Pumps and liquid supply systems for the three test zones are on the second flat bed in the center of the photograph. On the far end of this second flatbed, tubing leading from the drift crown to the water supply cylinder marks the position of the collar of the 20-m-long borehole. At the top right corner of the photograph, note the V-shaped curtain for collection of seepage water and two seepage collection cylinders into which water from the collection curtain drains.

ACCOMPLISHMENTS

We are in the first month of data collection in the first borehole. Air injection data indicate that the fracture permeability is on the order of 1.5 to 2.5 x 10^{-11} m^2. The liquid injection test needs to run around the clock and over a period of weeks, while the Cross Drift is only opened during the day shift four days per week. The control of the entire equipment system, test protocol and data evaluation is being conducted remotely from Berkeley.

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